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ABSTRACT DEADLINE:

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PROGRAM #

Direct R_2^* Measurements and Flow Insensitive T_2^* - Weighted Studies Indicate a Sustained Elevation of Blood Oxygenation During Long Term Activation

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INTRODUCTION:

Prior studies (1-4) have given conflicting results regarding the hemodynamic changes that occur during extended duration stimulation. Hathout et al. (1) have observed a decrease in T_2^* -weighted (blood oxygenation-weighted) MR signal after about 15 minutes of continuous stimulation. Krüger and Frahm et al. (2-3) have observed a decrease in T_2^* -weighted MR signal after about 2 minutes of continuous stimulation, but sustained flow weighted (T_1 -weighted) signal. Bandettini et al. (4) have observed sustained T_2^* -weighted signal and T_1 -weighted signal under a variety of stimuli except in conditions of clear habituation. One possible concern in these studies is that T_2^* -weighted sequences, even with a TR of 3 sec (4), might have some flow weighting.

To address the concern of possible flow weighting, two studies were carried out. In the first study, a time course series of R_2^* ($= 1 / T_2^*$) decay maps were directly obtained (5). These maps are insensitive to T_1 (flow related) changes. In the second study, a TR of 10 sec was used minimize T_1 and/or flow weighting.

METHODS:

Study 1: Echo-planar imaging was carried out on a Signa 1.5T scanner equipped with a balanced torque three axis gradient coil. Voxel volume was 3.75 mm x 3.75 mm x 5 mm. A series of R_2^* maps were obtained by cyclically incrementing the TE by 5 ms, in sequential echo planar images, from 30 ms to 75 ms. The R_2^* maps were calculated by a monoexponential fit to the decay curve. One map was obtained every ten seconds. The motor cortex activation paradigm was bilateral finger tapping. Timing was: 1 min off, 1 min on, 1 min off, 4 min on, 1 min off, 4 min on, 1 min off, 1 min on, 1 min off.

Study 2: Echo-planar imaging was carried out on a Signa 1.5T scanner retrofitted with an ANMR resonant gradient system. Voxel volume was 3.12 mm x 3.12 mm x 10 mm. A time course series of images having TE = 40 ms and TR = 10 sec were obtained. Visual stimulation timing was: 10 Hz full field black and white alternating checkerboard. The timing was: 1 min off, 1 min on, 1 min off, 20 min on, 1 min off, 1 min on, 1 min off.

Motion correction was performed for both studies.

RESULTS:

Figure 1 shows the measured R_2^* time course from motor cortex. R_2^* does not return to baseline at any time during either of the two 4 minute motor cortex activation periods. The extrapolated TE=0 value (sensitive to flow effects and insensitive to oxygenation effects), showed sustained elevation during activation. Figure 2 shows the time course of signal from the visual cortex using a TR of 10 sec. The signal remains elevated during the entire 20 minute stimulation period.

CONCLUSIONS:

Two studies have been carried out by which R_2^* changes, caused by blood oxygenation changes, were observed without contamination from flow effects. The conclusion is that blood flow and oxygenation remain elevated during extended duration cortical stimulation. The results of this study appear to coincide with those of Madsen et al. (6), using the Kety-Schmidt technique.

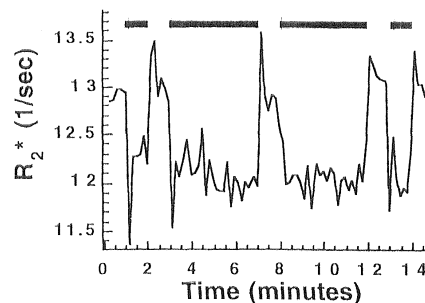


Figure 1: Time course of R_2^* from motor cortex during which the subject performed continuous finger tapping. During two periods of 1 minute and two periods of 4 minutes ΔR_2^* remained at about -0.8 1/s during activation.

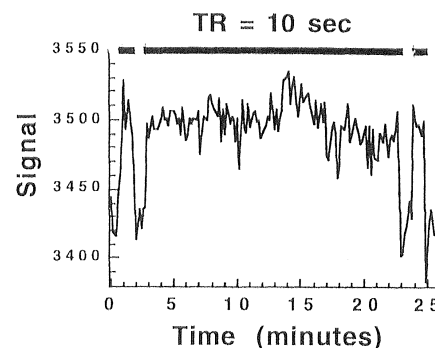


Figure 2: Flow insensitive (TR = 10 sec) T_2^* - weighted signal intensity during 20 minutes of sustained visual stimulation. The signal remains elevated during the entire activation period.

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